

- 1 1. A lock detection circuit in communication with a phase lock loop to detect
2 phase-frequency lock of an output frequency signal of said phase lock
3 loop with an input reference signal, comprising:
 - 4 a first logic function circuit to combine a frequency increase signal
5 and a frequency decrease signal of said phase lock loop to
6 provide a frequency deviation signal; and
 - 7 a second logic function circuit to combine the frequency deviation
8 signal with the input reference signal to determine that the
9 frequency deviation signal has a greater duration than a portion
10 of a cycle of said input reference signal and provide an error
11 signal.
- 1 2. The lock detection circuit of claim 1 further comprising a latching circuit in
2 communication with the second logic function and the input reference
3 signal to capture and retain said error signal to provide an unlock alarm
4 signal indicating loss of phase-frequency lock of said phase lock loop.
- 1 3. The lock detection circuit of claim 1 further comprising an integrator circuit
2 in communication with the second logic function to receive and integrate
3 the error signal and upon the error signal achieving an integrated
4 threshold level, transferring an unlock alarm indicating loss of phase-
5 frequency lock of said phase lock loop.

- 1 4. The lock detection circuit of claim 1 further comprising a frequency divider
- 2 connected to receive the input reference signal, divide said input reference
- 3 signal, and transfer the divided input reference signal to the second
- 4 function circuit, wherein said second logic function circuit combines the
- 5 deviation signal and the divided input reference signal to generate the
- 6 error signal.
- 1 5. The lock detection circuit of claim 1 wherein the first logic function circuit is
- 2 an OR gate.
- 1 6. The lock detection circuit of claim 1 wherein the second logic function
- 2 circuit is an AND gate.
- 1 7. A lock detection circuit in communication with a phase lock loop to detect
- 2 phase-frequency lock of an output frequency signal of said phase lock
- 3 loop with an input reference signal, comprising:
 - 4 a phase-frequency detector in communication with the phase lock
 - 5 loop to receive the output frequency signal and the input
 - 6 reference signal to generate a frequency increase signal and a
 - 7 frequency decrease signal indicative of an amount of phase-
 - 8 frequency deviation of the output frequency signal has from the
 - 9 input reference signal;
- 10 a first logic function circuit connected to the phase frequency
- 11 detector to combine a frequency increase signal and a

frequency decrease signal to provide a frequency deviation signal; and

14 a second logic function circuit to combine the frequency deviation
15 signal with the input reference signal to determine that the
16 frequency deviation signal has a greater duration than a portion
17 of a cycle of said input reference signal and provide an error
18 signal.

1 8. The lock detection circuit of claim 7 wherein the first logic function circuit is
2 an OR gate.

1 9. The lock detection circuit of claim 7 wherein the second logic function
2 circuit is an AND gate.

1 10. A phase lock loop system comprising:

2 a phase-frequency detector to detect a difference in frequency
3 between an output frequency of said phase lock loop and an
4 input reference frequency of said phase lock loop; and

5 a lock detection circuit to detect loss of phase-frequency lock of the
6 output frequency signal of said phase lock loop with the input
7 reference signal and upon detection of said loss of phase-
8 frequency lock provide an unlock alarm, said lock detection
9 circuit comprising:

10 a first logic function circuit to combine a frequency increase
11 signal and a frequency decrease signal received from said
12 phase-frequency detector to provide a frequency deviation
13 signal; and
14 a second logic function circuit to combine the frequency
15 deviation signal with the input reference signal to determine
16 that the frequency deviation signal has a greater duration
17 than a portion of a cycle of said input reference signal and
18 provide said unlock alarm.

- 1 11. The phase lock loop of claim 10 wherein the lock detection circuit further
2 comprises a latching circuit in communication with the second logic
3 function and the input reference signal to capture and retain said unlock
4 alarm to provide an unlock alarm signal indicating loss of phase-frequency
5 lock of said phase lock loop.

- 1 12. The phase lock loop of claim 10 wherein the lock detection circuit further
2 comprises an integrator circuit in communication with the second logic
3 function to receive and integrate the error signal and upon the error signal
4 achieving an integrated threshold level, transferring an unlock alarm
5 indicating loss of phase-frequency lock of said phase lock loop.

- 1 13. The phase lock loop of claim 10 wherein the lock detection circuit further
2 comprises a frequency divider connected to receive the input reference

3 signal, divide said input reference signal, and transfer the divided input
4 reference signal to the second function circuit, wherein said second logic
5 function circuit combines the deviation signal and the divided input
6 reference signal to generate the error signal.

7 14. The phase lock loop of claim 10 wherein the first logic function circuit is an
8 OR gate.

1 15. The phase lock loop of claim 10 wherein the second logic function circuit
2 is an AND gate.

1 16. A phase lock loop system comprising:

2 a lock detection circuit to detect loss of phase-frequency lock of an
3 output frequency signal of said phase lock loop with input
4 reference signal and upon detection of said loss of phase-
5 frequency lock provide an unlock alarm, said lock detection
6 circuit comprising:

7 a phase-frequency detector in communication with a voltage
8 controlled oscillator of the phase lock loop to receive the
9 output frequency signal and the input reference signal to
10 generate a frequency increase signal and a frequency
11 decrease signal indicative of an amount of phase-frequency
12 deviation of the output frequency signal has from the input
13 reference signal;

14 a first logic function circuit connected to the phase frequency
15 detector to combine a frequency increase signal and a
16 frequency decrease signal to provide a frequency deviation
17 signal; and

18 a second logic function circuit to combine the frequency
19 deviation signal with the input reference signal to determine
20 that the frequency deviation signal has a greater duration
21 than a portion of a cycle of said input reference signal and
22 provide said unlock alarm.

- 1 17. The phase lock loop of claim 16 wherein the first logic function circuit is an
- 2 OR gate.
- 1 18. The phase lock loop of claim 16 wherein the second logic function circuit
- 2 is an AND gate.
- 1 19. A clock extraction circuit to provide an alarm indicating that a local
- 2 oscillator signal is no longer in phase-frequency synchronism with an
- 3 reference timing signal extracted from a data stream, said clock extraction
- 4 circuit comprises:
 - 5 a clock extractor to remove said timing signal from said data
 - 6 stream;

7 a phase lock loop in communication with the clock extractor to
8 receive said timing signal and adjust a phase and frequency of
9 the local oscillator signal synchronize said local oscillator signal
10 to the timing signal; and

11 a lock detection circuit to detect loss of phase-frequency lock of the
12 local oscillator signal with the timing signal and upon detection
13 of said loss of phase-frequency lock provide an unlock alarm,
14 said lock detection circuit comprising:

15 a first logic function circuit to combine a frequency increase
16 signal and a frequency decrease signal received from said
17 phase lock loop to provide a frequency deviation signal, and

18 a second logic function circuit to combine the frequency
19 deviation signal with the timing signal to determine that the
20 frequency deviation signal has a greater duration than a
21 portion of a cycle of said timing signal and provide said
22 unlock alarm.

1 20. The clock extractor of claim 19 wherein the lock detection circuit further
2 comprises a latching circuit in communication with the second logic
3 function and the input reference signal to capture and retain said unlock
4 alarm to provide an unlock alarm signal indicating loss of phase-frequency
5 lock of said phase lock loop.

- 1 21. The clock extractor of claim 19 wherein the lock detection circuit further
- 2 comprises an integrator circuit in communication with the second logic
- 3 function to receive and integrate the error signal and upon the error signal
- 4 achieving an integrated threshold level, transferring an unlock alarm
- 5 indicating loss of phase-frequency lock of said phase lock loop.
- 1 22. The clock extractor of claim 19 wherein the lock detection circuit further
- 2 comprises a frequency divider connected to receive the input reference
- 3 signal, divide said input reference signal, and transfer the divided input
- 4 reference signal to the second function circuit, wherein said second logic
- 5 function circuit combines the deviation signal and the divided input
- 6 reference signal to generate the error signal.
- 7 23. The clock extractor of claim 19 wherein the first logic function circuit is an
- 8 OR gate.
- 1 24. The clock extractor of claim 19 wherein the second logic function circuit is
- 2 an AND gate.
- 1 25. A clock extraction circuit to provide an alarm indicating that a local
- 2 oscillator signal is no longer in phase-frequency synchronism with an
- 3 reference timing signal extracted from a data stream, said clock extraction
- 4 circuit comprises:
 - 5 a clock extractor to remove said timing signal from said data
 - 6 stream;

7 a phase lock loop in communication with the clock extractor to
8 receive said timing signal and adjust a phase and frequency of
9 the local oscillator signal synchronize said local oscillator signal
10 to the timing signal; and

11 a lock detection circuit to detect loss of phase-frequency lock of the
12 local oscillator signal with the timing signal and upon detection
13 of said loss of phase-frequency lock provide an unlock alarm,
14 said lock detection circuit comprising:

15 a phase-frequency detector in communication with the phase
16 lock loop to receive the output frequency signal and the input
17 reference signal to generate a frequency increase signal and
18 a frequency decrease signal indicative of an amount of
19 phase-frequency deviation of the output frequency signal
20 has from the input reference signal,

21 a first logic function circuit connected to the phase frequency
22 detector to combine a frequency increase signal and a
23 frequency decrease signal to provide a frequency deviation
24 signal, and

25 a second logic function circuit to combine the frequency
26 deviation signal with the timing signal to determine that the
27 frequency deviation signal has a greater duration than a

28 portion of a cycle of said timing signal and provide said
29 unlock alarm.

1 26. The clock extractor of claim 25 wherein the first logic function circuit is an
2 OR gate.

1 27. The clock extractor of claim 25 wherein the second logic function circuit is
2 an AND gate.

3 28. A synchronous communication receiver system to receive a synchronous
4 transport signal containing data and an embedded reference timing signal
5 and to extract said data and the reference timing signal, comprising:

6 a receiver to receive and buffer said synchronous transport signal;
7 and

8 a clock extraction circuit in communication with the receiver to
9 receive the synchronous transport signal and to provide an
10 alarm indicating that a local oscillator signal is no longer in
11 phase-frequency synchronism with an reference timing signal
12 extracted from a data stream, said clock extraction circuit
13 comprises:

14 a clock extractor to remove said timing signal from said
15 synchronous transport signal.

a phase lock loop in communication with the clock extractor to receive said reference timing signal and adjust a phase and frequency of the local oscillator signal synchronize said local oscillator signal to the timing signal, and

a lock detection circuit to detect loss of phase-frequency lock of the local oscillator signal with the timing signal and upon detection of said loss of phase-frequency lock provide an unlock alarm, said lock detection circuit comprising:

a first logic function circuit to combine a frequency increase signal and a frequency decrease signal received from said phase lock loop to provide a frequency deviation signal and

a second logic function circuit to combine the frequency deviation signal with the timing signal to determine that the frequency deviation signal has a greater duration than a portion of a cycle of said timing signal and provide said unlock alarm.

1 29. The synchronous communication receiver system of claim 28 wherein the
2 lock detection circuit further comprises a latching circuit in communication
3 with the second logic function and the input reference signal to capture

4 and retain said unlock alarm to provide an unlock alarm signal indicating
5 loss of phase-frequency lock of said phase lock loop.

1 30. The synchronous communication receiver system of claim 28 wherein the
2 lock detection circuit further comprises an integrator circuit in
3 communication with the second logic function to receive and integrate the
4 error signal and upon the error signal achieving an integrated threshold
5 level, transferring an unlock alarm indicating loss of phase-frequency lock
6 of said phase lock loop.

1 31. The synchronous communication receiver system of claim 28 wherein the
2 lock detection circuit further comprises a frequency divider connected to
3 receive the input reference signal, divide said input reference signal, and
4 transfer the divided input reference signal to the second function circuit,
5 wherein said second logic function circuit combines the deviation signal
6 and the divided input reference signal to generate the error signal.

1 32. The synchronous communication receiver system of claim 28 wherein the
2 first logic function circuit is an OR gate.

1 33. The synchronous communication receiver system of claim 28 wherein the
2 second logic function circuit is an AND gate.

1 34. A synchronous communication receiver system to receive a synchronous
2 transport signal containing data and an embedded reference timing signal
3 and to extract said data and the reference timing signal, comprising:

4 a receiver to receive and buffer said synchronous transport signal;

5 and

6 a clock extraction circuit in communication with the receiver to
7 receive the synchronous transport signal and to provide an
8 alarm indicating that a local oscillator signal is no longer in
9 phase-frequency synchronism with an reference timing signal
10 extracted from a data stream, said clock extraction circuit
11 comprises:

12 a clock extractor to remove said timing signal from said
13 synchronous transport signal,

14 a phase lock loop in communication with the clock extractor to
15 receive said reference timing signal and adjust a phase and
16 frequency of the local oscillator signal synchronize said local
17 oscillator signal to the timing signal, and

18 a lock detection circuit to detect loss of phase-frequency lock of
19 the local oscillator signal with the timing signal and upon
20 detection of said loss of phase-frequency lock provide an
21 unlock alarm, said lock detection circuit comprising:

22 a phase-frequency detector in communication with the phase
23 lock loop to receive the output frequency signal and the
24 input reference signal to generate a frequency increase

25 signal and a frequency decrease signal indicative of an
26 amount of phase-frequency deviation of the output
27 frequency signal has from the input reference signal,

28 a first logic function circuit connected to the phase frequency
29 detector to combine a frequency increase signal and a
30 frequency decrease signal to provide a frequency
31 deviation signal, and

32 a second logic function circuit to combine the frequency
33 deviation signal with the timing signal to determine that
34 the frequency deviation signal has a greater duration
35 than a portion of a cycle of said timing signal and provide
36 said unlock alarm.

- 1 35. The clock extractor of claim 34 wherein the first logic function circuit is an
2 OR gate.
- 1 36. The clock extractor of claim 34 wherein the second logic function circuit is
2 an AND gate.
- 1 37. A synchronous communication system for the transfer of a synchronous
2 transport signal, comprising:

3 a synchronous transmission apparatus to combine a data signal
4 and a timing reference signal to form the synchronous transport
5 signal; and

6 a synchronous communication receiver apparatus in
7 communication with the synchronous transmission apparatus to
8 receive the synchronous transport signal band to extract said
9 data and the reference timing signal, comprising:

10 a receiver to receive and buffer said synchronous transport
11 signal,

12 a clock extraction circuit in communication with the receiver to
13 receive the synchronous transport signal and to provide an
14 alarm indicating that a local oscillator signal is no longer in
15 phase-frequency synchronism with the reference timing
16 signal extracted from a synchronous transport signal, said
17 clock extraction circuit comprises:

18 a clock extractor to remove said timing signal from said
19 synchronous transport signal,

20 a phase lock loop in communication with the clock extractor
21 to receive said reference timing signal and adjust a
22 phase and frequency of the local oscillator signal

synchronize said local oscillator signal to the timing signal, and

a lock detection circuit to detect loss of phase-frequency lock of the local oscillator signal with the timing signal and upon detection of said loss of phase-frequency lock provide an unlock alarm, said lock detection circuit comprising:

a first logic function circuit to combine a frequency increase signal and a frequency decrease signal received from said phase lock loop to provide a frequency deviation signal, and

a second logic function circuit to combine the frequency deviation signal with the timing signal to determine that the frequency deviation signal has a greater duration than a portion of a cycle of said timing signal and provide said unlock alarm.

1 38. The synchronous communication system of claim 37 wherein the lock
2 detection circuit further comprises a latching circuit in communication with
3 the second logic function and the input reference signal to capture and
4 retain said unlock alarm to provide an unlock alarm signal indicating loss
5 of phase-frequency lock of said phase lock loop.

1 39. The synchronous communication system of claim 37 wherein the lock
2 detection circuit further comprises an integrator circuit in communication
3 with the second logic function to receive and integrate the error signal and
4 upon the error signal achieving an integrated threshold level, transferring
5 an unlock alarm indicating loss of phase-frequency lock of said phase lock
6 loop.

1 40. The synchronous communication system of claim 37 wherein the lock
2 detection circuit further comprises a frequency divider connected to
3 receive the input reference signal, divide said input reference signal, and
4 transfer the divided input reference signal to the second function circuit,
5 wherein said second logic function circuit combines the deviation signal
6 and the divided input reference signal to generate the error signal.

7 41. The synchronous communication system of claim 37 wherein the first logic
8 function circuit is an OR gate.

1 42. The synchronous communication system of claim 37 wherein the second
2 logic function circuit is an AND gate.

1 43. The synchronous communication system of claim 37 wherein said
2 synchronous communication system is a SONET communication system.

1 44. A synchronous communication system for the transfer of a synchronous
2 transport signal, comprising:

3 a synchronous transmission apparatus to combine a data signal
4 and a timing reference signal to form the synchronous transport
5 signal;

6 a synchronous communication receiver apparatus in
7 communication with the synchronous transmission apparatus to
8 receive the synchronous transport signal band to extract said
9 data and the reference timing signal, comprising:

10 a receiver to receive and buffer said synchronous transport
11 signal,

12 a clock extraction circuit in communication with the receiver to
13 receive the synchronous transport signal and to provide an
14 alarm indicating that a local oscillator signal is no longer in
15 phase-frequency synchronism with the reference timing
16 signal extracted from a synchronous transport signal, said
17 clock extraction circuit comprises:

18 a clock extractor to remove said timing signal from said
19 synchronous transport signal,

20 a phase lock loop in communication with the clock extractor
21 to receive said reference timing signal and adjust a
22 phase and frequency of the local oscillator signal

23 synchronize said local oscillator signal to the timing
24 signal, and

25 a lock detection circuit to detect loss of phase-frequency lock
26 of the local oscillator signal with the timing signal and
27 upon detection of said loss of phase-frequency lock
28 provide an unlock alarm, said lock detection circuit
29 comprising:

30 a phase-frequency detector in communication with the
31 phase lock loop to receive the output frequency signal
32 and the input reference signal to generate a
33 frequency increase signal and a frequency decrease
34 signal indicative of an amount of phase-frequency
35 deviation of the output frequency signal has from the
36 input reference signal,

37 a first logic function circuit connected to the phase
38 frequency detector to combine a frequency increase
39 signal and a frequency decrease signal to provide a
40 frequency deviation signal, and

41 a second logic function circuit to combine the frequency
42 deviation signal with the timing signal to determine
43 that the frequency deviation signal has a greater

44 duration than a portion of a cycle of said timing signal
45 and provide said unlock alarm.

1 45. The synchronous communication system of claim 44 wherein the first logic
2 function circuit is an OR gate.

1 46. The synchronous communication system of claim 44 wherein the second
2 logic function circuit is an AND gate.

1 47. The synchronous communication system of claim 44 wherein said
2 synchronous communication system is a SONET communication system.

1 48. A method for providing an unlock alarm denoting loss of phase frequency
2 synchronism of a phase lock loop comprising the steps of:

3 providing an input reference timing signal;
4 providing an increase frequency signal and a decrease frequency
5 signal from said phase lock loop said increase and decrease
6 frequency signals indicating existence of an error in the phase-
7 frequency between an input reference timing signal applied to
8 said phase lock loop and an output local oscillator signal;

9 performing a first logical combining of said increase frequency
10 signal and said decrease frequency signal to create a phase-
11 frequency deviation signal;

12 performing a second logical combining of said phase-frequency
13 deviation signal and the input reference timing signal;

14 if the phase-frequency deviation signal has a greater duration than
15 a portion of a cycle of said timing signal, providing the unlock
16 alarm signal.

1 49. The method of claim 48 further comprising the step of:

2 capturing and retaining said unlock alarm signal for transfer to
3 external circuitry.

4 50. The method of claim 48 further comprising the steps of:

5 integrating the unlock alarm signal; and
6 upon said integrated unlock alarm signal surpassing a threshold
7 value transferring externally said unlock alarm signal.

1 51. The method of claim 48 further comprising the step of:

2 dividing the input reference timing signal; and
3 performing the second logical combining the phase-frequency error
4 signal and the divided input reference timing signal.

5 52. The method of claim 48 wherein the first logical combining is an OR
6 function.

1 53. The method of claim 48 wherein the second logic logical combining is an
2 AND function.

1 54. A method for providing an unlock alarm denoting loss of phase frequency
2 synchronism of a phase lock loop comprising the steps of:
3 providing an input reference timing signal;
4 providing an output timing signal from said phase lock loop;
5 detecting a phase-phase frequency deviation between the output
6 timing signal and the input reference timing signal;
7 if said output timing signal lags or has a lower frequency than said
8 input reference timing signal providing an increase frequency
9 signal;
10 if said output timing signal leads or has a higher frequency than
11 said input reference timing signal providing a decrease
12 frequency signal;
13 performing a first logical combining of said increase frequency
14 signal and said decrease frequency signal to create a phase-
15 frequency deviation signal;
16 performing a second logical combining of said phase-frequency
17 deviation signal and the input reference timing signal;

18 if the phase-frequency deviation signal has a greater duration than
19 a portion of a cycle of said timing signal, providing the unlock
20 alarm signal.

21 55. The method of claim 54 wherein the first logical combining is an OR
22 function.

1 56. The method of claim 54 wherein the second logic logical combining is an
2 AND function.